

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

A281.9

A28

cap. 1

#15

HIGH-ROUGHAGE RATIONS FOR DAIRY HEIFERS



Production Research Report No. 15

U. S. DEPARTMENT OF AGRICULTURE
Agricultural Research Service

Washington, D.C.

EXTRA COPY

LIBRARY
RECEIVED
JAN 15 1958

CONTENTS

	Page
Background of the study.....	3
Experimental procedure.....	4
Results and discussion.....	7
Summary and conclusions.....	19
Literature cited.....	20

Issued December 1957

1963 ARTXZ

HIGH-ROUGHAGE RATIONS FOR DAIRY HEIFERS

By the Animal Husbandry Research Division, Agricultural Research Service ¹

BACKGROUND OF THE STUDY

For many years the usual recommendation for feeding dairy calves has been to feed whole milk or skim milk to 6 months of age and grain for the entire period of growth. Usually from 3 to 4 pounds of grain is fed per day during most of this period. Under this system, a heifer will consume from 2,000 to 3,500 pounds of concentrates from birth to first calving. In an experiment at the Agricultural Research Center, Beltsville, Md. (9),² Holstein and Jersey heifers that were limited to a maximum of 3 pounds of grain (concentrate mixture) per day consumed an average of 2,151 and 1,888 pounds of grain, respectively, during this period. On a more liberal grain allowance, Jersey heifers at the Missouri station consumed an average of 2,907 pounds of grain from birth to 24 months of age, and Holstein heifers consumed an average of 3,663 pounds during the same period (7). Growth was normal.

Since a ton of grain usually costs 2 to 3 times as much as a ton of hay, the cost of raising a dairy heifer to maturity is materially affected by the amount of grain fed. Any reduction in this part of the ration should reduce the cost of rearing herd replacements. Interest in this general problem has been accentuated by the emphasis on grassland farming, which stresses production of large quantities of forage. More information is needed not only on how to use forage efficiently in livestock production but also on how to use it to reduce the cost of rearing herd replacements.

Several groups of investigators have conducted work along these lines. As early as 1924, Reed, Fitch, and Cave (8) noted that heifers raised exclusively on either alfalfa hay or alfalfa hay and corn silage from 6 months of age to calving and without grain at any time failed to develop satisfactorily. In 1948, on the other hand, the Oregon station (10) reported satisfactory growth of dairy heifers raised from 6 months of age to calving on only hay, pasture, and salt, and without grain. In both these experiments, milk was fed to 6 months of age.

The effect on dairy heifers of restricting grain consumption during the growing period and of eliminating grain from the ration during certain intervals has also been studied. Stallcup, Herman, and Ragsdale (11) obtained slightly (but not statistically significant) subnormal growth of dairy heifers fed a total of 796 pounds of grain to 24 months of age. Other heifers fed as much as 1,232 pounds of

¹ This publication is based on a preliminary manuscript and summary of data prepared by H. T. Converse, now retired, when he was a member of the former Bureau of Dairy Industry.

² Italic numbers in parentheses refer to Literature Cited, p. 20.

grain and still others that received no grain from 15 to 24 months of age were also slightly below normal at 24 months of age. All these heifers received milk until 6 or 7 months of age, and hay, silage, and pasture.

Hodgson et al. (4) successfully reared dairy heifers from 12 or 14 months of age to calving on hay and pasture only. They had been fed a dry skim-milk ration to 6 months of age and grain and hay from 6 months to 12 or 14 months of age. Graves et al. (2) reported that heifers raised on hay and pasture from 12 to 24 months of age made as good gains as heifers fed 2 or 3 pounds of grain daily in addition to hay and pasture. They also reported satisfactory growth by dairy heifers fed alfalfa hay only from 12 to 18 months of age, and hay, pasture, and grain from 18 to 24 months of age, as compared to similar heifers fed hay, pasture, and grain during the 12- to 18-month period. Hibbs et al. (3) reported recently on high-roughage rations for young dairy calves.

In experiments begun in 1942 at the Agricultural Research Center, Beltsville, Md., to determine how much earlier than 6 months of age dairy calves could be safely weaned from milk, satisfactory growth was obtained when milk feeding was discontinued as early as 30 to 60 days of age (1). During the course of these investigations, some preliminary tests were made to determine the amount of grain needed for satisfactory growth on a limited-milk feeding system. A few calves made satisfactory gains when grain feeding was discontinued at 8 or 9 months of age.

The present experiments were then set up to determine (1) whether dairy heifers would make satisfactory gains on a limited-milk, limited-grain feeding system and (2) to what extent hay and silage could be used in the ration.

EXPERIMENTAL PROCEDURE

Eight groups of Holstein and Jersey calves were assigned to these experiments. The groupings and feeds fed to the respective groups are shown in table 1. The heifers in each group were maintained on the ration indicated from birth to 24 months of age.

All calves received colostrum to 3 or 4 days of age. The heifers in group 1 were changed from colostrum to skim milk at 4 days of age. The milk-feeding period for the heifers in group 1 ranged from 30 to 90 days, as follows: 2 Holsteins were weaned at 30 days of age and had consumed an average of about 310 pounds of milk; 3 Holsteins were weaned at 45 days and had consumed an average of 409 pounds of milk; 3 Jerseys were weaned at 60 days of age and had consumed an average of 534 pounds of milk; and 1 Jersey was weaned at 90 days of age and had consumed 877 pounds of milk.

Most of the calves in groups 2 to 8 were changed to whole milk at 4 days of age. However, 1 or 2 calves in groups 2 to 5 were fed colostrum for the entire milk-feeding period, at the same level of dry-matter intake as calves fed whole milk. Previous studies have shown that colostrum and whole milk have equal feeding value for dairy calves when fed on this basis (5). All the heifers in groups 2 to 8 were weaned at 60 days of age, and they had consumed, on an average, the equivalent of about 350 pounds of whole milk.

Grain was placed before the heifers at 10 days of age and fed as indicated in table 2. The heifers in groups 2 to 7, inclusive, were

TABLE 1.—*Feeding schedule for 8 groups of Holstein and Jersey heifers on a limited-milk, limited-grain feeding system*

Group, number of animals, and breed	Milk ¹	Grain	Forages
Group 1: 5 Holsteins and 4 Jerseys-----	Skim milk to 30, 45, 60, or 90 days.	Fed to 11 months (total, 726-826 pounds).	U. S. No. 1 alfalfa and timothy hay; corn silage.
Group 2: 3 Holsteins and 5 Jerseys-----	Colostrum or whole milk to 60 days.	Fed to 8 or 9 months (total, 550-560 pounds).	Do.
Group 3: 2 Holsteins and 5 Jerseys-----	do-----	do-----	U. S. No. 1 alfalfa and timothy hay; cornstalk silage.
Group 4: 2 Holsteins and 5 Jerseys-----	do-----	do-----	U. S. No. 1 alfalfa, timothy, and homegrown orchardgrass-ladino hay.
Group 5: 2 Holsteins and 4 Jerseys-----	do-----	do-----	U. S. No. 1 alfalfa hay.
Group 6: 4 Jerseys-----	Whole milk to 60 days-----	do-----	U. S. No. 1 alfalfa hay; corn silage.
Group 7: 2 Jerseys-----	do-----	do-----	Homegrown bromegrass-ladino or orchardgrass-ladino hay; corn silage.
Group 8: 3 Jerseys-----	do-----	Fed to 24 months (total, 2,276 pounds).	U. S. No. 1 alfalfa hay; corn silage.

¹ All calves were fed colostrum until 3 or 4 days of age.

allowed to eat according to appetite until the Jerseys were consuming a maximum of 3 pounds per day and the Holsteins, $3\frac{1}{2}$ pounds per day. The grain allowance was reduced for the Jerseys starting at 7 months of age and for the Holsteins starting at 6 months, and this reduction was continued until no grain was fed to the Holsteins after 8 months of age and to the Jerseys after 9 months. There were some variations in this schedule. If a calf was behind schedule at any particular period, it was allowed to continue at a higher level than called for in succeeding months until it had caught up to schedule. All calves in groups 2 to 7 consumed a similar total amount of grain (550 pounds for Jerseys and 560 pounds for Holsteins).

TABLE 2.—*Grain allowance, by months, for Jerseys and Holsteins in groups 2 to 7, inclusive*¹

Month	Jerseys	Holsteins
	<i>Pounds</i>	<i>Pounds</i>
First.....	10	15
Second.....	30	45
Third.....	60	105
Fourth.....	90	115
Fifth.....	90	105
Sixth.....	90	85
Seventh.....	75	60
Eighth.....	60	30
Ninth.....	45	0
Tenth.....	0	0
Total.....	550	560

¹ If a calf was behind schedule in grain consumption at any time, it was allowed to continue at the maximum rate until it had caught up to the schedule.

The heifers in group 1 were on a similar grain-feeding schedule except that grain feeding was continued until they were about 11 months of age. Total consumption was 726 pounds for Jerseys and 826 pounds for Holsteins. The data for groups 1 and 2 provide a direct comparison of the effects of two levels of grain feeding on the growth of dairy heifers fed similar forages.

The heifers in group 8 were on a different grain-feeding schedule. About 3.5 pounds of grain was fed per day from 5 months of age to calving. Total consumption was 2,276 pounds. The data for group 8 and group 6 provide an additional comparison of the effects of a limited versus a more liberal grain-feeding schedule on the growth of dairy heifers fed similar forages.

The composition of the concentrate mixture fed to the heifers was as follows: Cornmeal, 300 pounds; linseed oil meal, 250 pounds; soybean oil meal, 250 pounds; wheat bran, 200 pounds; and salt, 10 pounds. A few of the first heifers were fed the following concentrate mixture: Cornmeal, 400 pounds; linseed oil meal, 200 pounds; wheat bran, 400 pounds; and salt, 10 pounds.

All heifers had free access to salt during the time they were in the exercise lot.

Hay was placed before the heifers when they were about 10 days of age. With the exception of group 7, only alfalfa hay was fed until the heifers were about 4 months of age. Timothy hay (where

fed) was then added, and corn silage (where fed) was added at about 5 months of age. Good-quality forages were used throughout the experiments (except for group 3, as indicated). With the exception of the homegrown hay, all hay was graded U. S. No. 1. The homegrown hay was also of good quality; it was barn dried and was equal to U. S. No. 1 hay. The corn silage was made from well-eared corn and was of good quality when fed.

The data for groups 2 to 7 provide a direct comparison of the value of various hays fed alone or in combination with other hays and corn silage on the growth of dairy heifers fed similar limited amounts of milk and grain, with no milk after 60 days of age and no grain from 9 to 24 months of age.

Heifers were assigned to the first 5 groups at random as they became available over a 3-year period. Groups 6, 7, and 8 were added during 1 year when the pattern of results with the first 5 groups had been fairly well established. Two different types of forages were introduced. These three small groups provide a further check on the effect of feeding increased amounts of grain on growth of dairy heifers. In addition, the setting up of these groups within a short interval reduced to a minimum any possible variability in quality of forage fed in different years. These considerations, together with the fact that the results obtained with these small groups were not greatly different from the results obtained with the other larger groups, justify inclusion of the data.

All heifers were fed individually, and detailed records were kept of feed offered and refused. Weights were obtained on 3 consecutive days at 30-day intervals. In addition single weights were also obtained at 10-day intervals until the heifers were 1 year old.

The body weight and gains of these heifers were compared with the Ragsdale standard (6). The data were subjected to an analysis of variance, and tests of significance between appropriate groups were made.

RESULTS AND DISCUSSION

A condensed summary of feed consumption, body weight, and gains during the first year of development of these heifers is presented in table 3. Table 4 contains similar data for the second year. A more detailed analysis of feed consumption and growth is presented in tables 5, 6, and 7.

TABLE 3.—Average total feed consumption per heifer during the first year by 8 groups of heifers fed limited amounts of milk and grain, and their average gain in body weight as compared with the expected normal ¹

Breed and group	Animals	Feed consumption					Body weight		
		Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay	Corn silage	At birth	At 12 months	Gain
		<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Holsteins:	<i>Number</i>								
Group 1	5	826	547	1, 286	—	1, 976	79	613	534
Group 2	3	564	295	2, 047	—	2, 613	88	639	551
Group 3	2	564	412	1, 650	—	² 1, 299	89	545	456
Group 4	2	566	460	2, 211	670	—	89	654	565
Group 5	2	563	—	3, 134	—	—	101	636	535
Expected normal	—	—	—	—	—	—	90	632	542
Jerseys:									
Group 1	4	726	452	957	—	1, 553	65	469	404
Group 2	5	550	283	1, 122	—	1, 768	58	437	379
Group 3	5	553	385	1, 301	—	² 1, 133	54	418	364
Group 4	5	563	326	1, 540	281	—	51	467	416
Group 5	4	547	—	2, 201	—	—	57	453	396
Group 6	4	532	—	1, 725	—	1, 781	54	497	443
Group 7	2	551	—	—	³ 1, 385	2, 460	55	493	438
Group 8	3	998	—	1, 418	—	1, 459	54	499	445
Expected normal	—	—	—	—	—	—	53	450	397

¹ The Ragsdale standard (6) was used as the expected normal in these comparisons.

² Cornstalk silage.

³ Mostly bromegrass-ladino hay, but some orchardgrass-ladino hay was also fed.

TABLE 4.—Average total feed consumption per heifer during the second year by 8 groups of heifers fed limited amounts of milk and grain, and their average gain in body weight as compared with the expected normal¹

Breed and group	Animals	Feed consumption					Body weight		
		Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay	Corn silage	At 12 months	At 24 months	Gain
Holsteins:									
Group 1	Number	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Group 2	4	None	1, 360	3, 413	—	5, 205	608	1, 058	451
Group 3	3	None	1, 277	4, 179	—	6, 673	639	1, 158	519
Group 4	2	None	1, 562	4, 433	—	2 3, 216	545	981	436
Group 5	2	None	1, 372	5, 697	946	—	654	1, 070	416
Group 6	2	None	—	7, 709	—	—	636	1, 063	427
Expected normal	—	—	—	—	—	—	632	1, 069	437
Jerseys:									
Group 1	4	None	1, 057	2, 619	—	5, 149	469	794	325
Group 2	5	None	551	2, 680	—	4, 813	437	788	351
Group 3	5	None	1, 129	3, 864	—	2 2, 521	418	762	344
Group 4	5	None	803	4, 421	787	—	467	788	321
Group 5	4	None	—	5, 707	—	—	453	702	309
Group 6	4	None	—	2, 745	—	6, 777	497	834	338
Group 7	2	None	—	—	3 1, 964	8, 442	493	872	379
Group 8	3	4 1, 278	—	2, 357	—	4, 910	499	826	327
Expected normal	—	—	—	—	—	—	450	733	283

¹ The Ragsdale standard (6) was used as the expected normal in these comparisons.

² Cornstalk silage.

³ Mostly brome-grass-ladino hay, but some orchard-grass-ladino hay was also fed.

⁴ Total grain consumption for 2 years=2,276 pounds.

TABLE 5.—Average feed consumption per heifer per day and average body weight of Holstein heifers fed limited amounts of milk and grain, by group and period

Group and period ¹	Feed consumption per heifer per day					Average body weight per heifer
	Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay	Corn silage ²	
Group 1—						
Period:	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1.....	0.53	-----	0.05	-----	-----	96
2.....	2.27	-----	.45	-----	-----	126
3.....	3.27	-----	1.56	-----	-----	165
4.....	3.77	0.16	2.82	-----	-----	215
5.....	3.97	.32	3.62	-----	0.70	267
6.....	3.80	.55	4.98	-----	1.03	320
7.....	3.30	1.66	3.53	-----	5.50	372
8.....	2.80	2.42	2.98	-----	8.97	427
9.....	2.00	3.08	3.88	-----	9.93	476
10.....	1.13	3.09	5.41	-----	11.07	518
11.....	.53	2.99	6.38	-----	13.57	564
12.....	.17	2.42	6.39	-----	12.97	613
13.....	-----	2.74	8.31	-----	14.57	638
14.....	-----	2.84	9.71	-----	15.03	678
15.....	-----	2.71	9.53	-----	15.00	711
16.....	-----	3.01	9.27	-----	15.37	749
17.....	-----	2.90	8.31	-----	15.23	777
18.....	-----	3.31	7.06	-----	20.13	814
19.....	-----	3.61	6.91	-----	15.30	858
20.....	-----	3.39	7.15	-----	15.83	870
21.....	-----	3.74	7.38	-----	15.87	924
22.....	-----	3.48	7.39	-----	16.23	956
23.....	-----	3.75	7.87	-----	16.87	1,013
24.....	-----	3.77	8.28	-----	17.63	1,058
Group 2—						
Period:						
1.....	.37	-----	.07	-----	-----	115
2.....	1.93	-----	.54	-----	-----	158
3.....	3.47	-----	2.61	-----	-----	203
4.....	3.83	.33	3.21	-----	.03	256
5.....	3.43	.98	4.63	-----	2.53	310
6.....	2.90	1.14	5.90	-----	10.40	360
7.....	2.07	.72	6.26	-----	13.20	415
8.....	.87	.80	6.44	-----	13.50	459
9.....	-----	1.29	8.19	-----	11.93	502
10.....	-----	1.44	9.04	-----	13.87	545
11.....	-----	1.36	10.12	-----	21.67	589
12.....	-----	1.33	9.77	-----	18.57	639
13.....	-----	2.04	9.53	-----	18.07	692
14.....	-----	1.82	10.70	-----	19.53	742
15.....	-----	2.25	11.22	-----	18.67	780
16.....	-----	3.18	10.40	-----	20.17	839
17.....	-----	2.24	12.82	-----	20.67	881
18.....	-----	2.44	12.50	-----	20.50	910
19.....	-----	2.96	11.10	-----	16.17	937
20.....	-----	3.92	10.41	-----	16.37	967
21.....	-----	4.79	11.16	-----	18.00	1,007
22.....	-----	5.14	10.59	-----	18.60	1,070
23.....	-----	5.43	13.63	-----	16.20	1,112
24.....	-----	5.43	13.08	-----	16.66	1,158

See footnotes at end of table, p. 12.

TABLE 5.—Average feed consumption per heifer per day and average body weight of Holstein heifers fed limited amounts of milk and grain, by group and period—Continued

Group and period ¹	Feed consumption per heifer per day					Average body weight per heifer
	Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay	Corn silage ²	
Group 3—						
Period:	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
1.....	0.20	-----	-----	-----	-----	102
2.....	1.23	-----	0.32	-----	-----	137
3.....	2.90	-----	1.22	-----	-----	166
4.....	3.47	0.19	2.09	-----	-----	202
5.....	3.43	.94	2.55	-----	-----	251
6.....	3.43	.90	3.39	-----	2.87	307
7.....	2.83	1.50	4.25	-----	6.10	364
8.....	2.03	2.12	6.35	-----	5.43	400
9.....	1.00	2.47	7.80	-----	5.70	438
10.....	-----	1.49	7.05	-----	6.83	464
11.....	-----	1.80	7.77	-----	7.70	498
12.....	-----	1.97	10.03	-----	7.40	558
13.....	-----	2.09	10.97	-----	4.97	581
14.....	-----	2.35	11.00	-----	4.67	618
15.....	-----	3.00	11.67	-----	7.40	668
16.....	-----	2.80	11.55	-----	10.00	690
17.....	-----	2.57	13.37	-----	8.83	719
18.....	-----	3.64	13.02	-----	8.10	758
19.....	-----	5.09	10.82	-----	11.93	777
20.....	-----	4.33	11.49	-----	14.00	824
21.....	-----	5.57	12.29	-----	12.03	890
22.....	-----	7.62	11.40	-----	11.37	916
23.....	-----	7.85	11.95	-----	8.93	942
24.....	-----	4.39	15.65	-----	4.26	981
Group 4—						
Period:						
1.....	.43	-----	.07	-----	-----	110
2.....	1.87	-----	.70	-----	-----	154
3.....	3.43	-----	2.20	-----	-----	198
4.....	3.83	.49	2.67	-----	-----	248
5.....	3.40	1.18	3.89	-----	-----	305
6.....	2.87	1.60	5.79	0.97	-----	356
7.....	1.93	2.00	6.84	1.84	-----	415
8.....	1.10	2.24	7.43	2.75	-----	470
9.....	-----	2.30	7.95	3.92	-----	511
10.....	-----	1.69	9.90	4.07	-----	563
11.....	-----	1.85	11.15	4.22	-----	617
12.....	-----	1.72	12.95	3.97	-----	652
13.....	-----	2.07	13.99	2.79	-----	685
14.....	-----	2.20	16.35	2.14	-----	716
15.....	-----	2.42	16.00	1.85	-----	750
16.....	-----	2.17	15.89	2.10	-----	794
17.....	-----	2.39	15.77	1.79	-----	830
18.....	-----	2.95	16.02	1.97	-----	871
19.....	-----	3.02	17.20	1.94	-----	900
20.....	-----	4.87	16.59	2.20	-----	932
21.....	-----	5.77	14.52	3.09	-----	988
22.....	-----	5.87	15.12	2.92	-----	987
23.....	-----	5.32	15.47	3.32	-----	1,029
24.....	-----	5.76	14.59	4.67	-----	1,057

See footnotes at end of table, p. 12.

TABLE 5.—Average feed consumption per heifer per day and average body weight of Holstein heifers fed limited amounts of milk and grain, by group and period—Continued

Group and period ¹	Feed consumption per heifer per day					Average body weight per heifer
	Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay	Corn silage ²	
Group 5— Period:	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1.....	0.37	-----	0.09	-----	-----	120
2.....	2.03	-----	.72	-----	-----	157
3.....	3.13	-----	2.07	-----	-----	201
4.....	3.93	-----	3.80	-----	-----	256
5.....	3.50	-----	6.44	-----	-----	304
6.....	2.97	-----	7.74	-----	-----	356
7.....	1.90	-----	9.59	-----	-----	405
8.....	1.00	-----	11.75	-----	-----	451
9.....	.07	-----	13.20	-----	-----	492
10.....	-----	-----	14.34	-----	-----	525
11.....	-----	-----	15.40	-----	-----	586
12.....	-----	-----	16.86	-----	-----	636
13.....	-----	-----	18.90	-----	-----	665
14.....	-----	-----	19.67	-----	-----	701
15.....	-----	-----	20.52	-----	-----	760
16.....	-----	-----	22.25	-----	-----	782
17.....	-----	-----	21.82	-----	-----	833
18.....	-----	-----	20.95	-----	-----	879
19.....	-----	-----	21.20	-----	-----	907
20.....	-----	-----	22.09	-----	-----	925
21.....	-----	-----	22.22	-----	-----	980
22.....	-----	-----	23.12	-----	-----	1,017
23.....	-----	-----	22.45	-----	-----	1,025
24.....	-----	-----	19.55	-----	-----	1,063

¹ 30-day periods except 12 and 24, which were 35 days.

² Group 3 was fed cornstalk silage.

TABLE 6.—Average feed consumption per heifer per day and average body weight of Jersey heifers fed limited amounts of milk and grain, by group and period

Group and period ¹	Feed consumption per heifer per day					Average body weight per heifer
	Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay ²	Corn silage ³	
Group 1— Period:	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1	0.33					65
2	1.07		0.25			92
3	2.13		.74			113
4	2.80	0.23	1.48			142
5	3.50	.34	2.52			184
6	3.90	1.11	3.01			233
7	3.47	1.37	3.17		3.13	285
8	3.13	1.88	2.87		6.17	323
9	2.43	2.24	2.46		8.50	365
10	1.20	2.88	3.96		8.93	408
11	.30	2.09	5.27		10.53	432
12		2.52	5.49		12.43	469
13		2.99	5.96		12.47	504
14		2.93	6.41		12.13	526
15		2.85	6.40		13.73	559
16		2.82	6.67		14.33	584
17		3.22	7.38		13.20	601
18		3.03	7.70		12.67	615
19		2.74	7.32		13.97	647
20		2.88	7.49		14.60	674
21		3.04	7.62		14.17	699
22		2.49	7.89		15.53	722
23		2.77	7.68		16.13	758
24		3.00	7.51		16.03	794
Group 2— Period:						
1	.10					67
2	.70		.18			88
3	2.03		.96			112
4	2.80	.29	1.67			144
5	3.20	.65	2.62			180
6	3.20	.75	2.80		2.70	222
7	2.93	.87	2.93		4.57	267
8	2.07	1.01	3.35		8.37	310
9	1.30	1.17	3.92		10.13	348
10		1.23	5.23		10.00	377
11		1.55	6.09		10.03	402
12		1.66	6.55		11.26	437
13		1.13	7.37		11.80	488
14		1.10	7.28		12.87	498
15		1.25	6.57		14.23	531
16		1.25	6.70		14.33	562
17		1.39	7.35		13.73	589
18		1.85	7.69		13.77	610
19		1.58	8.60		13.93	631
20		1.61	8.17		12.87	631
21		1.66	6.77		13.33	692
22		1.76	7.32		11.20	720
23		1.61	7.55		11.37	753
24		1.88	6.70		14.63	788

Footnotes at end of table, p. 16.

TABLE 6.—Average feed consumption per heifer per day and average body weight of Jersey heifers fed limited amounts of milk and grain, by group and period—Continued

Group and period ¹	Feed consumption per heifer per day					Average body weight per heifer
	Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay ²	Corn silage ³	
Group 3— Period:	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1.....	0. 17		0. 03			70
2.....	. 87		. 34			92
3.....	1. 77		1. 12			103
4.....	2. 67	0. 17	1. 67			139
5.....	3. 30	. 65	2. 13			180
6.....	3. 33	. 67	2. 44		2. 77	225
7.....	3. 03	. 83	2. 79		4. 40	260
8.....	1. 80	1. 19	3. 68		6. 07	300
9.....	1. 10	1. 55	5. 45		6. 00	331
10.....		2. 17	6. 23		6. 30	350
11.....		2. 11	7. 66		6. 73	383
12.....		3. 01	8. 41		4. 66	418
13.....		2. 07	10. 85		4. 37	454
14.....		2. 28	10. 81		3. 80	484
15.....		2. 42	9. 61		5. 57	515
16.....		2. 80	10. 31		4. 97	543
17.....		2. 38	12. 66		4. 67	580
18.....		2. 29	12. 14		6. 07	579
19.....		3. 19	10. 04		9. 20	596
20.....		3. 20	10. 17		10. 60	628
21.....		3. 40	8. 93		12. 93	661
22.....		3. 43	10. 46		11. 77	696
23.....		4. 85	10. 59		5. 30	720
24.....		4. 54	11. 62		4. 14	762
Group 4— Period:						
1.....	. 10					66
2.....	. 57		. 30			88
3.....	1. 80		1. 23			112
4.....	2. 73	. 13	1. 98			149
5.....	3. 23	. 37	2. 80			193
6.....	3. 23	. 66	3. 55	0. 32		235
7.....	2. 80	. 81	4. 71	. 56		279
8.....	2. 50	. 88	5. 79	. 97		321
9.....	1. 50	1. 21	6. 27	1. 58		357
10.....		1. 50	7. 43	1. 66		384
11.....		2. 01	8. 03	1. 67		420
12.....		2. 83	7. 93	2. 23		467
13.....		2. 44	9. 99	2. 14		497
14.....		2. 85	10. 69	2. 03		539
15.....		2. 53	10. 57	2. 31		558
16.....		1. 57	12. 68	1. 89		589
17.....		1. 89	12. 97	2. 30		610
18.....		1. 41	13. 96	1. 75		629
19.....		1. 98	12. 53	1. 99		652
20.....		2. 53	11. 80	2. 41		667
21.....		2. 19	12. 23	2. 13		691
22.....		2. 07	12. 60	1. 81		724
23.....		2. 29	12. 34	2. 16		751
24.....		2. 59	12. 86	2. 86		788

Footnotes at end of table, p. 16.

TABLE 6.—Average feed consumption per heifer per day and average body weight of Jersey heifers fed limited amounts of milk and grain, by group and period—Continued

Group and period ¹	Feed consumption per heifer per day					Average body weight per heifer
	Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay ²	Corn silage ³	
Group 5—						
Period:	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1	0. 13		0. 02			72
2	. 73		. 24			90
3	2. 30		1. 03			119
4	3. 30		2. 02			161
5	3. 10		3. 32			202
6	3. 03		4. 64			241
7	2. 40		6. 20			287
8	2. 10		8. 16			330
9	1. 20		9. 98			369
10			11. 07			396
11			12. 41			420
12			13. 02			453
13			14. 07			490
14			15. 21			518
15			16. 00			537
16			15. 75			568
17			15. 02			607
18			15. 03			632
19			14. 56			657
20			15. 29			680
21			15. 93			708
22			16. 75			741
23			17. 04			762
24			16. 78			762
Group 6—						
Period:						
1	. 20					71
2	. 85		. 22			96
3	2. 50		1. 45			129
4	3. 04		2. 05		0. 93	166
5	3. 26		2. 85		2. 48	209
6	2. 76		4. 68		3. 43	261
7	2. 11		6. 71		4. 30	301
8	1. 72		6. 75		5. 56	347
9	1. 24		7. 11		7. 65	385
10			7. 36		9. 24	417
11			8. 24		10. 47	455
12			9. 31		13. 07	496
13			8. 18		13. 95	526
14			7. 68		16. 38	560
15			7. 38		18. 28	588
16			6. 40		21. 04	617
17			7. 16		19. 27	636
18			6. 50		19. 97	645
19			7. 70		18. 61	677
20			6. 48		18. 75	729
21			8. 03		20. 14	740
22			8. 01		19. 52	772
23			7. 95		18. 66	797
24			8. 22		17. 36	840

Footnotes at end of table, p. 16.

TABLE 6.—Average feed consumption per heifer per day and average body weight of Jersey heifers fed limited amounts of milk and grain, by group and period—Continued

Group and period ¹	Feed consumption per heifer per day					Average body weight per heifer
	Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay ²	Corn silage ³	
Group 7—						
Period:	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1.....	0. 09	-----	-----	-----	-----	76
2.....	. 66	-----	-----	0. 40	-----	103
3.....	1. 96	-----	-----	1. 79	-----	141
4.....	2. 80	-----	-----	1. 98	1. 02	174
5.....	3. 33	-----	-----	3. 37	2. 46	222
6.....	3. 25	-----	-----	4. 75	5. 51	279
7.....	2. 75	-----	-----	4. 74	7. 44	335
8.....	2. 01	-----	-----	4. 53	9. 25	383
9.....	1. 50	-----	-----	6. 70	10. 67	403
10.....	-----	-----	-----	5. 74	12. 91	434
11.....	-----	-----	-----	6. 01	13. 31	456
12.....	-----	-----	-----	5. 39	16. 59	493
13.....	-----	-----	-----	3. 76	19. 19	529
14.....	-----	-----	-----	3. 16	23. 08	561
15.....	-----	-----	-----	3. 67	23. 07	576
16.....	-----	-----	-----	2. 78	24. 59	625
17.....	-----	-----	-----	6. 96	20. 56	647
18.....	-----	-----	-----	8. 73	22. 84	675
19.....	-----	-----	-----	4. 94	26. 21	694
20.....	-----	-----	-----	5. 40	25. 84	726
21.....	-----	-----	-----	4. 37	27. 01	758
22.....	-----	-----	-----	6. 16	22. 17	792
23.....	-----	-----	-----	7. 14	21. 07	826
24.....	-----	-----	-----	6. 36	22. 08	922
Group 8—						
Period:						
1.....	. 08	-----	-----	-----	-----	71
2.....	. 60	-----	0. 26	-----	-----	72
3.....	2. 31	-----	1. 06	-----	-----	119
4.....	2. 35	-----	2. 49	-----	. 97	151
5.....	3. 06	-----	2. 90	-----	1. 96	192
6.....	3. 34	-----	2. 79	-----	2. 40	233
7.....	3. 47	-----	4. 40	-----	4. 26	285
8.....	3. 49	-----	5. 75	-----	4. 68	315
9.....	3. 49	-----	6. 62	-----	5. 52	393
10.....	3. 50	-----	6. 98	-----	6. 20	442
11.....	3. 50	-----	6. 36	-----	8. 13	465
12.....	3. 50	-----	5. 21	-----	12. 35	499
13.....	3. 50	-----	5. 38	-----	14. 42	522
14.....	3. 50	-----	6. 67	-----	14. 95	554
15.....	3. 50	-----	5. 74	-----	18. 55	592
16.....	3. 50	-----	5. 42	-----	15. 73	558
17.....	3. 50	-----	5. 65	-----	18. 47	648
18.....	3. 50	-----	5. 94	-----	15. 29	664
19.....	3. 50	-----	6. 89	-----	10. 45	678
20.....	3. 50	-----	7. 13	-----	10. 63	703
21.....	3. 50	-----	6. 33	-----	12. 21	733
22.....	3. 50	-----	7. 35	-----	10. 52	776
23.....	3. 50	-----	8. 51	-----	9. 00	806
24.....	3. 50	-----	6. 48	-----	8. 60	826

¹ 30-day periods except 12 and 24, which were 35 days.

² Group 7 was fed some orchardgrass-ladino hay, but mostly brome-grass-ladino hay. ³ Group 3 was fed cornstalk silage.

TABLE 7.—Average total feed consumption per heifer from birth to 24 months of age by 8 groups of heifers fed limited amounts of milk and grain

Breed and group	Grain	Timothy hay	Alfalfa hay	Orchard-grass-ladino hay	Corn silage	Corn-stalk silage
Holstein:	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Group 1-----	826	1, 907	4, 699	-----	7, 181	-----
Group 2-----	564	1, 572	6, 226	-----	9, 286	-----
Group 3-----	564	1, 974	6, 083	-----	-----	4, 515
Group 4-----	566	1, 832	7, 908	1, 616	-----	-----
Group 5-----	563	-----	10, 843	-----	-----	-----
Jersey:						
Group 1-----	726	1, 509	3, 576	----- ^a	6, 702	-----
Group 2-----	550	834	3, 802	-----	6, 581	-----
Group 3-----	553	1, 514	5, 165	-----	-----	3, 654
Group 4-----	563	1, 129	5, 961	1, 068	-----	-----
Group 5-----	547	7, 908	-----	-----	-----	-----
Group 6-----	532	-----	4, 470	-----	8, 558	-----
Group 7-----	551	-----	-----	¹ 3, 349	10, 902	-----
Group 8-----	2, 276	-----	3, 775	-----	6, 369	-----

¹ Mostly bromegrass-ladino hay, but some orchardgrass-ladino hay was fed this group.

With one or two exceptions, these heifers had reached approximately the expected normal body weight at 24 months of age, and they had made normal gains irrespective of the forage fed.

At 12 months of age, the average weight of all the Holstein heifers was 615 pounds as compared to the expected normal of 632 pounds. At 24 months of age, the heifers averaged 1,072 pounds in weight as compared to the expected normal of 1,069 pounds. Their average grain consumption up to 2 years of age was 645 pounds. Grain consumption by the Holsteins in groups 2 to 5 averaged 564 pounds.

The average weight of the 29 Jerseys that were fed a limited grain ration was 462 pounds at 12 months of age and 793 pounds at 24 months, as compared to expected normal weights of 450 pounds and 733 pounds at 12 and 24 months of age, respectively. Their average grain consumption was 574 pounds. Grain consumption by the heifers in groups 2 to 7 ranged from 532 to 564 pounds, with an average of 555 pounds.

In these experiments, increased growth rates were not obtained when more than 560 pounds of grain was fed. This will be seen by comparing the data for groups 1 and 2 and for groups 6 and 8. The heifers in these groups were fed the same kinds of forages, the only variable being the increased grain feeding to groups 1 and 8.

The minimal amount of grain needed with this type of ration may be less than 560 pounds. In other experiments at Beltsville,³ 2 Holstein heifers fed a total of 435 pounds and 305 pounds of grain, respectively, have made normal gains. Another group of 7 Holstein and 10 Jersey heifers fed grains in amounts ranging from 250 to 525 pounds during the first 8 months and only alfalfa hay as roughage have made satisfactory gains.

³ Unpublished data.

Except for group 3, the growth rate of the heifers was not affected by either the type or the combination of forages fed. The average body weight of the heifers in the other groups was comparable, and no consistent or statistically significant differences which could be ascribed to differences in the rations were evident.

The heifers in group 3 were fed cornstalk silage (corn silage from which the ears were removed before ensiling). They did not make as rapid gains as the heifers in the other groups and were below normal in size throughout the experimental period.

The difference in average body weight between the Holsteins in group 3 and the Holsteins in the other groups was not statistically significant.

Although the Jersey heifers in group 3 attained the expected normal weight at 2 years of age, they weighed less than the Jerseys in the other groups. At 1 year of age, the average body weight of the Jerseys in group 3 was significantly less than in groups 6, 7, and 8; at 2 years, however, the difference was significant only for group 7.

Our observations indicate that the smaller gains by the heifers in group 3 did not result from feeding silage that contained no corn grain. No corn silage was fed to the heifers in groups 4 and 5, but they made just as satisfactory gains as heifers in other groups that were fed corn silage. Most of the cornstalk silage fed to the group 3 heifers had been ensiled in small experimental silos and was not well preserved. Average daily consumption of this silage by 3 Jerseys during the 21st month was 7.0 pounds. Some cornstalk silage that had been ensiled in a large conventional silo and that was well preserved was also fed for a short period. Average daily consumption of this silage by 2 Jersey heifers was 15.6 and 28.1 pounds. When this silage was transferred to the experimental silos and was fed after a brief storage period, consumption by the same 2 heifers dropped to 7.1 and 11.7 pounds daily. Thus, the determining factor in the rather poor results obtained with the group 3 heifers seemed to be the poor quality of the silage and the resulting lowered consumption.

The average body weight of the Jerseys in groups 6, 7, and 8 was consistently greater than that of the Jerseys in any of the other groups at both 12 and 24 months of age. The differences between individual groups were not statistically significant. However, when the average body weight of all the Jerseys in these 3 groups was compared with the average body weight of all the Jerseys in groups 1 to 5, the difference was statistically significant. As noted previously, groups 6, 7, and 8 were added in a relatively short time interval toward the end of these experiments, and this may have contributed to the difference.

The average birth weight of the Jerseys in groups 6, 7, and 8 was not materially different from that of the Jerseys in groups 1 to 5. However, their feed consumption during the first year was greater than for any of the other groups. Some timothy hay was fed to the heifers in groups 1 to 4, whereas no timothy was fed to groups 6 and 8. Group 7 heifers were fed brome-grass-ladino or orchard-grass-ladino hay, which contained about 30 percent of legumes. These observations suggest that it may be important to maintain a relatively high legume content in the hay fed in a limited-milk, limited-grain feeding system.

It should be emphasized again that the quality of the forages fed in these experiments was generally excellent. Whether similar results could be obtained with poorer quality hay and silage has not been determined, but it is probably significant that the only difficulty in these experiments occurred with the heifers in group 3 that were fed roughages consisting in part of poor-quality cornstalk silage.

The heifers in these experiments were overfed, and in some instances grossly overfed, on protein during both years. There appears to be little danger that heifers will be underfed on protein on any high-roughage ration that contains a reasonable quantity of legume hay. It appears also that good-quality forage furnishes a fairly complete ration for growing dairy heifers, including probably any unknown factors.

SUMMARY AND CONCLUSIONS

This publication is a report of experimental work at the Agricultural Research Center, Beltsville, Md., to determine whether dairy heifers would make satisfactory growth on a ration consisting largely of roughage, with much less milk and grain than is usually recommended. The usual recommendation in calf feeding is to feed whole or skim milk to 6 months of age and 3 or 4 pounds of grain per day during most of the period of growth.

These experiments have shown that Jersey and Holstein heifers may be grown to normal size at 2 years of age on a variety of forage rations when milk feeding is limited to 60 days and grain feeding is limited to the first 9 months.

Thirty-four heifers (9 Holsteins and 25 Jerseys), fed about 560 pounds of grain during the first 8 or 9 months and none thereafter, attained expected normal growth at 24 months of age. They were fed six different combinations of forages. Nine additional heifers (5 Holsteins and 4 Jerseys), on similar forages, were fed grain until about 11 months of age and 3 Jersey heifers were fed grain until 24 months of age without increasing their growth rate.

The type or combination of forages used in these experiments did not appear to affect growth rates materially. Similar results were obtained when alfalfa hay was the sole forage fed; when alfalfa hay was combined with corn silage, or with timothy hay and corn silage, or with timothy hay and orchardgrass-ladino hay; or when bromegrass-ladino hay or orchardgrass-ladino hay was fed with corn silage.

The forages fed in these experiments were generally of excellent quality, and all the rations provided an excess of protein. The extent to which poorer quality forages could be used in a limited-milk, limited-grain feeding system has not been determined. Unsatisfactory results obtained when poor-quality forages made up a part of the ration fed to one group of animals indicate that forages of uniformly good quality should be used in such a system. There was also some slight indication that it is important to maintain a relatively high legume content in high-roughage rations for growing dairy heifers.

LITERATURE CITED

- (1) CONVERSE, H. T.
1949. EXPERIMENTS IN REARING CALVES WITHOUT WHOLE MILK AND WITH LIMITED AMOUNTS OF SKIM MILK. U. S. Dept. Agr. Cir. 822, 31 pp., illus.
- (2) GRAVES, R. R., DAWSON, J. R., KOPLAND, D. V., SIMMS, J. A., VAN HORN, A. G., and CATHCART, S. L.
1940. RATE OF GROWTH BY DAIRY CALVES AND HEIFERS ON DIFFERENT RATIONS. U. S. Dept. Agr. Cir. 560, 23 pp., illus.
- (3) HIBBS, J. W., POUNDEN, W. D., and CONRAD, H. R.
1953. A HIGH ROUGHAGE SYSTEM FOR RAISING CALVES BASED ON THE EARLY DEVELOPMENT OF RUMEN FUNCTION.
I. EFFECTS OF VARIATION IN THE RATION ON GROWTH, FEED CONSUMPTION AND UTILIZATION. Jour. Dairy Sci. 36: 717-727.
II. GROWTH, FEED CONSUMPTION, AND UTILIZATION BY CALVES FED A 3:2 RATION OF HAY TO GRAIN WITH OR WITHOUT MOLASSES OR PENICILLIN SUPPLEMENTS. Jour. Dairy Sci. 36: 1319-1325.
III. EFFECT OF RUMEN INOCULATIONS AND THE RATIO OF HAY TO GRAIN ON DIGESTION AND NITROGEN RETENTION. (Conrad and Hibbs.) Jour. Dairy Sci. 36: 1326-1334.
- (4) HODGSON, R. E., KNOTT, J. C., MILLER, V. W., and MURER, H. K.
1938. THE NUTRITIVE VALUE OF HOME-GROWN ROUGHAGE RATIONS FOR DAIRY CATTLE. Wash. Agr. Expt. Sta. Bul. 366, 80 pp., illus.
- (5) JACOBSON, W. C., CONVERSE, H. T., WISEMAN, H. G., and MOORE, L. A.
1951. THE EFFECT OF SUBSTITUTING COLOSTRUM FOR WHOLE MILK IN THE RATION OF DAIRY CALVES. Jour. Dairy Sci. 34: 905-910.
- (6) RAGSDALE, A. C.
1934. GROWTH STANDARDS FOR DAIRY CATTLE. Mo. Agr. Expt. Sta. Bul. 336, 12 pp., illus.
- (7) ———
1934. FEED CONSUMPTION OF DAIRY CATTLE DURING GROWTH. Mo. Agr. Expt. Sta. Bul. 338, 16 pp., illus.
- (8) REED, O. E., FITCH, J. B., and CAVE, H. W.
1924. THE RELATION OF FEEDING AND AGE AT CALVING TO THE DEVELOPMENT OF DAIRY HEIFERS. Kans. Agr. Expt. Sta. Bul. 233, 38 pp., illus.
- (9) SHEPHERD, J. B., and MILLER, F. W.
1940. FEEDING, CARE, AND MANAGEMENT OF YOUNG DAIRY STOCK. U. S. Dept. Agr. Farmers' Bul. 1723, 43 pp., illus.
- (10) SHERWOOD, D. H., and JONES, I. R.
1948. RAISING DAIRY HEIFERS ON ROUGHAGE ALONE AND WITH GRAIN. Oreg. Agr. Expt. Sta. Inf. Cir. 427, 8 pp. (Processed.)
- (11) STALLCUP, O. T., HERMAN, H. A., RAGSDALE, A. C.
1949. THE GROWTH OF DAIRY HEIFERS RAISED CHIEFLY ON ROUGHAGE. Mo. Agr. Expt. Sta. Bul. 523, 12 pp., illus.